CHAPTER 3
AIRWORTHINESS STANDARDS
NORMAL CATEGORY ROTORCRAFT

MISCELLANEOUS GUIDANCE (MG)

AC 27 MG 6. EMERGENCY MEDICAL SERVICE (EMS) SYSTEMS INSTALLATIONS INTERIOR ARRANGEMENTS, AND EQUIPMENT.

a. Explanation. This paragraph pertains to EMS configurations and associated rotorcraft airworthiness standards. EMS configurations are usually unique interior arrangements that are subject to the appropriate airworthiness standards, FAR Part 27 or its predecessor CAR Part 6, to which the rotorcraft was certificated. No relief from the standards is intended except by § 21.21(b)(1) or exemption. EMS configurations are seldom, if ever, done by the original manufacturer.

(1) The FAA/AUTHORITY has not specified in the airworthiness or operating rules the minimum equipment for an EMS configuration. Whatever equipment is presented for evaluation and approval is subject to compliance with the airworthiness standards. Any equipment that is not essential to safe operation of the aircraft is evaluated for a “no hazard approval,” i.e., it is optional equipment and may be approved provided the use, operation, and possible failure modes of the equipment are not hazardous to the aircraft. Safe flight, safe landing, and prompt evacuation of the rotorcraft, in the event of a minor crash landing, for any reason, are the objectives of the FAA/AUTHORITY evaluation of interiors and equipment unique to EMS.

(i) For example, a rotorcraft equipped only for transportation of a nonambulatory person (a police rotorcraft with one litter) as well as a rotorcraft equipped with multiple litters and complete life support systems and two or more trained attendants/medical personnel may be submitted for approval. These configurations will be evaluated to the airworthiness standards appropriate to the rotorcraft certification basis.

(ii) Normal category rotorcraft should comply with flightcrew and passenger safety standards which result in certain features of the basic certified rotorcraft which are related to the arrangement, to the doors and emergency exits, and to occupant protection. Compliance with the airworthiness standards results in placards or markings for doors and exits, exit size, exit quantity and location, exit access, safety belts, and possibly shoulder harnesses or other restraint or passenger protection means as a part of a rotorcraft type design. These features, including any placards and markings which are required to be a part of the rotorcraft type design, should be retained unless specific replacements or alternate designs are necessary for the EMS configuration to comply with the airworthiness standards.

(2) Many EMS configurations of normal rotorcraft are equipped with the following:

(i) Attendant/medical personnel seats, which may swivel.

(ii) Multiple litters, some of which tilt.

(iii) Medical equipment stowage compartments.

(iv) Life support and other complex medical equipment.

(v) Incubators for infants.

(vi) Curtains or other interior light shielding for the flightcrew station.

(vii) External loud speakers and search lights.

(viii) Special internal (intercom) and external communication radio equipment.

b. Procedures.

(1) General.

(i) Original type design information and criteria may or may not be available from the manufacturer. This may be "public," not proprietary, information that is pertinent for interior modifications. It may be appropriate to include "standard" features, placards, and markings for the rotorcraft type design by reference in the applicant's modification design data.

(ii) The EMS modification presented for approval usually contains equipment of one manufacturer's model or design. The type design of the modification will have features to power and restrain the equipment, maintain the rotorcraft systems integrity, and to otherwise protect the occupants. See paragraph b(15) which refers to equipment substitution.

(2) Evacuation and Interior Arrangements. Access to the emergency exits/doors from any location in the cabin/compartment, access to and use of the exit/door opening means or release device, and the unobstructed area of an exit are potential problems that should be addressed in the early design stage. Multi-litter arrangements may be especially critical for normal category rotorcraft.

(i) The operation or use of devices for locking the position of swivel seats, etc., and for rapid installation and removal of litters (incubators, etc.) should be labeled unless they are simple and obvious, and do not require exceptional effort. The design features of the device(s) and the seat and/or litter will influence the extent of information in any label necessary to insure proper and safe installation for routine use and for prompt evacuation when appropriate or necessary for the interior arrangement.

The requirement for labels or markings (instructions, etc.) that applies to operation of seat or litter features, release devices, etc., is not relieved even if trained attendants are necessary for an evacuation as discussed in c(2)(v). Placards or instruction cards that contain evacuation procedures do not necessarily contain detail procedures for individual seats, litters, and so forth. Release devices that are simple and obvious and do not require exceptional effort are recommended. For example, a single central control for litter release would be preferred over multiple action release devices. Seats and litters which require multiple actions or steps to position or release for an emergency evacuation after minor crash landing may be acceptable if properly scrutinized and evaluated for the effect on achieving a rapid evacuation.

(ii) The passenger compartment should not be partitioned to impede access to exits. Exit/doors should be readily accessible. A door or exit is required on each side of the rotorcraft. A demonstration or a "walk-through" of appropriate evacuation procedures may be necessary to insure the means and procedures are feasible and adequate. Rotorcraft with readily accessible exits, using simple and obvious means and procedures for an evacuation, may not require written procedures or a demonstration. Placards and durable markings, if necessary, may be sufficient to complement the exit markings and instructions required by the standards.

(iii) It is <u>preferable</u> for the patient to remain strapped in the litter; however, the patient may be removed from the litter to facilitate prompt evacuation in the event of a minor crash landing as defined in § 27.561(b). If evacuation procedures and trained attendants are necessary for rapid evacuation, the procedures may be prominently displayed in durable markings, placards, cards, and summarized or condensed in the Emergency Procedures Section of the Rotorcraft Flight Manual (RFM) or an EMS configuration supplement to the RFM. If medical attendants are required for evacuation, the attendants should be trained in evacuation procedures and listed as trained attendants in the Limitations Section of the RFM or supplement. A trained attendant is not considered a flightcrew member but is a required "crewmember."

(3) <u>Restraint of Occupants and Equipment</u>.

(i) The minor crash conditions specified in § 27.561(c) usually dictate all but the vertical (down and possibly up) design load conditions. The flight and landing loads, such as ±3.5g limit (flight) vertical, usually override the minor crash loads. See paragraphs AC 27.561 and AC 27.785 for further information.

(ii) Galleys, medical supplies, and equipment compartments or modules should be restrained and the individual compartments should also contain the contents therein for the conditions noted in b(3)(i). Durable placards, decals, or markings should be used where appropriate to limit the maximum weight of any compartment and the whole module. Compartment latches having sufficient strength and displacement/engagement should be used to contain the contents for the conditions noted. If necessary, a static load test or analysis should be employed to insure the container/compartment remains intact and the latch does not disengage for the most critical conditions. Loose or unrestrained contents in an individual compartment, in combination with similar compartments, should require use of a magnification factor with the design conditions noted. Prudent design and location of compartments having heavy, unrestrained (loose) equipment will mitigate the potential effects of minor crash impact loads.

(iii) Whether seated or recumbent, the occupants must be protected as prescribed in § 27.785. Swivel seats and tilt litters may be used provided they are substantiated for the appropriate loads for the positions selected for approval. Placards or markings may be used to assure proper orientation for flight takeoff and landing and minor crash conditions. For recumbent occupants, harnesses, straps, a padded headboard, a diaphragm, or safety belts may be used if proven for the forward and lateral loads of §27.561(c). Harnesses/straps are preferred, however, for the forward condition. When harnesses/straps are used, they should prevent the occupant from significant forward motion (4g condition) that would remove the support for the head as well as the shoulder for “head-down” motion. The litter design should become a part of the interior design approval. The type design for the interior should include the litter and incubator part numbers. Infants in incubators should be similarly protected by padding and containment within the incubator with the incubator restrained for the load cases noted. If the infant is strapped to a removable platform, the platform and infant should be properly restrained within the incubator for the load cases noted. Incubator materials are also subject to the flammability standards noted in paragraph b(4) that follows.

(4) Flammability Standards for Materials.

(i) Interior materials must meet the flammability standards in § 27.853, appropriate to the type design. The standard presently requires compartment materials to be at least flash resistant. The wall and ceiling linings, coverings of upholstery, floors and furnishings must be at least flame resistant.

(A) Flash-resistant material may be characterized as that not exceeding a 20-inch-per-minute (horizontal) burn rate. See AC 23-2 for further information.

(B) Flame-resistant material may be characterized as that not exceeding a 4-inch-per-minute (horizontal) burn rate.

(C) However, self-extinguishing materials that can meet the transport rotorcraft standards of § 29.853 of Amendment 29-17 are readily available. These self-extinguishing materials are recommended for use in normal category rotorcraft.

(ii) For incubators, transparencies must be flash resistant and fabric (padding, covers) straps, etc., must be flame resistant according to the standard. Advisory Circular No. 23-2, Flammability Tests, dated August 20, 1984, contains test information about flash and flame-resistant material.

(5) Exit Signs/Markings and External Markings. Doors and exits must have signs and markings (instructions) for prompt evacuation even in darkness. An emergency light system is not required by Part 27. Refer to the RFM or maintenance manual for "standards" placards, decals, stencils, etc. Alternates may be approved as a part of the interior type design.

(6) Interior or "Medical" Lights. The view of the flightcrew must be free from glare and reflections that could cause interference. Curtains that meet the flammability standards (flame resistant) may be used. Complete partitioning or separation of the flightcrew and passenger area is not prudent. Means for visual and oral communication are usually necessary. Reference paragraph AC 27.773 concerning pilot visibility (§ 27.773).

(7) External Devices.

(i) Search lights, loud speakers, baggage pods, etc., may be installed on the underside of or elsewhere on the rotorcraft. The strength of the attachments must be proven for the flight and landing conditions and possibly for the minor crash conditions where applicable. Pilot view/visibility should not be adversely affected by the lights and reflections from the lights.

(ii) The device or pod located on the underside of the rotorcraft should not contact a level landing surface after "limit landing load" deflection of the landing gear. That is, the landing gear should deflect under limit load without causing damage to the device. For example, if the gear limit landing load deflection is 8 inches, the device must have at least an 8-inch ground clearance to avoid contact with the landing surface.

(iii) The physical characteristics of the rotorcraft landing gear design dictate the necessary clearance. The type design owner has this proprietary design information. A conservative deflection value may be chosen in place of obtaining proprietary design information. (The limit landing descent velocity specified in § 27.725(a) ranges from 6.5 to 8.3 feet per second.)

(iv) The device should also be designed and located to preclude penetration into a critical area of the fuselage such as fuel cell, fuel line, primary control tube, or occupant seat in the event of higher landing impact velocities.

(v) In addition, flight evaluation is necessary to determine the effects of the device on the rotorcraft flight characteristics and on flightcrew night visibility.

(8) Patient Interference. When passengers or patients are located in close proximity to the pilot and the primary flight controls of the rotorcraft, a guard or shield must be installed or the patient must be restrained to prevent inadvertent or potential convulsive interference with safe operation of the rotorcraft. The guard may be a part of

the rotorcraft interior features. In addition, prompt evacuation must be assured if a guard is used.

(9) Miscellaneous. Several paragraphs in this AC contain guidance for the standards cited in the reference list (reference c(1)). These paragraphs should provide insight into designing an EMS configuration that would be acceptable under the standards.

(10) Oxygen. EMS oxygen installations are supplied by either liquid or gaseous oxygen. Both types of systems are discussed in this paragraph.

(i) Liquid Oxygen.

(A) System General Description. This section covers specific requirements for liquid oxygen systems. Most liquid oxygen systems in use are installed in military aircraft and, as a result, much of this material is based on experience with these systems. A rotorcraft liquid oxygen system should be comprised of a liquid oxygen converter, tubing, fittings, quantity gage, heat exchangers, and appropriate pressure and flow control components as shown in figures AC 27 MG 6-1 and AC 27 MG 6-2. The installation may provide for replenishing the liquid oxygen supply by use of a quick-removable converter or, in the case of a fixed installation converter, by providing external access for connection to a portable service trailer. More complicated systems such as those with multiple converter assemblies are not discussed here since installation of those systems are not envisioned in rotorcraft at this time.

(B) System Components. All components should be aircraft qualified and suitable for use in an EMS rotorcraft application.

(1) Liquid Oxygen Converter. A liquid oxygen converter assembly is a self-powered system for the storage of liquid oxygen and for its conversion to gaseous oxygen when required. A principal part of the converter assembly is a vacuum insulated container. Pressure relief valves should be provided to allow the escape of gas generated when oxygen is not being expended in the supply line. Oxygen losses from a converter assembly vary from 5 to 20 percent per 24 hours depending on the size of the container, its installation environment, and so forth. Aircraft qualified and approved converters suitable for EMS rotorcraft use are available in either 5- or 50-liter capacities. Size selection should be determined by flow rate and duration requirements. Performance characteristics of each converter size are available from the manufacturer.

(2) Shutoff Valve Assembly. This valve should be accessible to a flightcrew member and be mounted in the supply line on or as close as possible to the outlet of the converter. This valve provides for the confinement of the remaining supply of liquid oxygen to the converter in the event of an emergency. Since the system pressure is low, the use of an electrically actuated shutoff valve is satisfactory to accomplish this function. In some installations, where the evaporating coil is immediately adjacent to the converter, a flow fuse has been used to accomplish this

function. Use of a flow fuse must be supported by a system fault analysis and testing to show maximum normal flow will not result in nuisance trips, and reliable trips will be provided for malfunction conditions resulting in excess flow.

(3) Filler Valve. Some designs combine this function with the build-up and vent valve assembly as shown in figure AC 27 MG 6-2.

(4) Build-up and Vent Valve Assembly. This valve is positioned in the "vent" position when the system is being filled with oxygen and in the "build-up position at other times. Some designs combine this function with the filler valve as shown in figure AC 27 MG 6-2.

(5) Pressure Build-up Coil Assembly and Pressure Closing Valve. With the build-up and vent valve in the "build-up" position gas that is formed is allowed to apply pressure to the liquid to provide adequate flow through the check valve to the evaporating coil assembly. A connection to a pressure relief valve is also provided.

(6) Evaporating Coil Assembly. This is provided to convert the liquid oxygen into a gaseous form. The evaporating coil assembly should be of sufficient capacity to maintain the design flow quantity to the dispensing regulators at a temperature within +10 and -20° F of cabin ambient temperature. MIL-D-19326G contains a discussion of installation considerations for this unit.

(7) Vent Line. Gaseous oxygen escapes through this line. At the conclusion of the fill operation, liquid oxygen will flow overboard in a steady stream from this line to indicate the container is full of liquid oxygen. The vent line should be located to drain overboard at the bottom of the rotorcraft fuselage. Flow from the overboard vent should be directed so as not to create a hazard for personnel and not allow liquid oxygen to impinge on the rotorcraft. The vent lines should be insulated to prevent frosting and sweating if they pass over equipment which will be harmed by water dripping from the lines, or drip pans should be installed under the lines. There should be no hydrocarbon fills or drains, forward or above, in proximity to the vent outlet.

(8) Regulator. A regulator should be installed in the supply line downstream from the heat exchanger. The regulator should reduce the liquid oxygen converter operating pressure to a supply pressure of 50 pounds per square inch gauge (PSIG) to be compatible with the normal operating pressure of medical oxygen equipment.

(9) Flow Control Valve. This valve provides a calibrated flow of gaseous oxygen from an operating supply of 50 ± 5 PSIG. A valve whose proof pressure is specified at 80 PSIG and has a burst pressure rating of 350 PSIG would be considered satisfactory.

(10) Check Valve. This valve prevents gaseous oxygen in the supply system from backing up into the liquid oxygen in the container and increasing the

vaporization rate of the liquid oxygen by exposure to the gas. This valve is normally an integral part of the liquid oxygen converter assembly.

(11) Quantity Indicators. A quantity indicator should be installed at the appropriate rotorcraft crew station to permit monitoring of the liquid oxygen supply. The indicator when installed in the rotorcraft should indicate the amount of liquid oxygen in the converter. Adequate clearance should be provided for the indicator connectors so that they can be readily disconnected by servicing personnel. Provisions should be made for the storage of the rotorcraft connectors to the liquid oxygen converter when they are disconnected. Liquid oxygen quantity indicating equipment is available in three types: capacitance gauging, electro-mechanical transducer indication, and differential pressure type indication.

(12) Pressure Relief Valves. Pressure relief valves are provided to vent overboard through the overboard vent system any excess pressures developing within the system.

(13) Lines. Lines should be either solid tubing or flexible hoses. Examples of acceptable solid tubing are aluminum alloy conforming to AMS 4071 or corrosion resistant annealed steel (304) confirming to MIL-T-8506. Flexible hoses should be used for rotorcraft system connections to removable converters and to other applications where relative movement may occur. Flexible hoses should be wire-braid-covered bellows or wire-braid-covered tetrafluoroethylene. Flexible hose conforming to MS90457 or MS24548 would be considered satisfactory. MS90457 hose is flexible to -297° F (-183° C), and MS24548 hose is flexible to -65° F (-54° C). Synthetic lines such as plastic, nylon, or rubber should not be used for lines subjected to continuous pressure, or for application where the line will not be visible. Lines that are not visible are those that are located behind liners or in the walls of the fuselage.

(14) Fittings. If in contact, dissimilar metals should be suitably protected against electrolytic corrosion. Line assemblies should be terminated with “B” nuts or a similar manufactured terminating connection. Universal adapters (AN 807) or friction nipples used in conjunction with hose clamps should be avoided for use in pressurized systems.

(15) Drain Valve. Systems that have permanently installed containers should include a drain valve located to allow for complete draining of the liquid oxygen container. An acceptable drain valve would be one in accordance with MK-V-25962 that is suitably capped. A cap in accordance with AN 929-5 with a permanently attached chain is a suitable cap.

(16) Low Pressure, Low Level Warning System. It is recommended that provisions be included in the system to alert the appropriate aircraft crew member that the level of the oxygen supply has reached some low level. It is recommended that low level be actuated when less than 10 percent of the full container capacity is available. If low system pressure is also monitored, the low pressure valve selected should be such

that any drop in supply line pressure upon inhalation should not activate the low pressure warning function.

(C) Component Installation. The following are typical installation considerations that should be addressed when designing the oxygen system.

(1) Location. The oxygen equipment, lines, and fittings should be located as remotely as practicable from sources of flammable fluids, high heat and electrical items, fuel, oil, hydraulic fluid, batteries, exhaust stacks, manifolds, and so forth. Oxygen lines should not be grouped with lines carrying flammable fluids. If possible, converters should not be in line with the plane of rotation of a turbine. System components should not be installed in an environment that will exceed the temperature limit of the component, and no part of the system should be installed in an area that will exceed 350° F (176° C). To minimize loss due to heat, the liquid oxygen converter should not be located near equipment that dissipates a high quantity of heat.

(2) Converter Mounting. The oxygen container should be readily accessible to servicing personnel. If the container is not removable for servicing, the filler should be external to the aircraft with adequate contamination protection. Mounting provisions for the converter and plumbing to the evaporating coil assembly should include a drain pan with an overboard drain.

(3) Flexible Hoses. Hoses should be of sufficient length to provide unstressed connections and be protected against chafing on surfaces or objects which may damage the wire covering. The bend radius imposed on the hoses by the installation and during remove and replace actions should not be less than the minimum established by the hose specifications.

(4) Lubricants. No lubricants should be used on liquid oxygen pipe fittings. MIL-T-27730 Teflon tape may be used on male pipe fittings when required. Teflon tape should not be used on flared tube fittings, straight threads, coupling sleeves, or on the outer side of tube flares. None of the tape should be allowed to enter the inside of a fitting. Krytox fluorinated grease by E.I. Dupont De Nemours and Company, or an equivalent, may be used sparingly on seals.

(5) Tubing Routing and Mounting. There should be at least 2 inches of clearance between the oxygen system and flexible moving parts of the rotorcraft. There should be at least a ½-inch clearance between the oxygen system and rigid parts of the rotorcraft. The oxygen system tubing, fittings, and equipment should be separated at least 6 inches from all electrical wiring, heat conduits, and heat emitting equipment in the rotorcraft. Insulation should be provided on adjacent hot ducts, conduits, or equipment to prevent heating of the oxygen system. In routing the tubing, the general policy should be to keep total length to a minimum. Allow for expansion, contraction, vibration, and component replacement. All tubing should be mounted to prevent vibration and chafing. This should be accomplished by the proper use of rubberized or cushion clips installed at 24-inch intervals (copper) or 36-inch intervals (aluminum) and

as close to the bends as possible. The tubing, where passing through or supported by the rotorcraft structure, should have adequate protection against chafing by the use of flexible grommets or clips. The tubing should not strike against the rotorcraft structure during vibration and shock encountered during normal use of the rotorcraft.

(6) System Marking. The rotorcraft should be permanently and legibly marked, as applicable, in the locations specified below (a minimum letter height of ¼ inch is recommended):

(i) Adjacent to the overboard vent opening:

CAUTION
LIQUID OXYGEN VENT

(ii) On outside surface of filler box cover plate:

LIQUID OXYGEN (BREATHING) FILL ACCESS

(iii) On underside surface of filler box cover plate:

CAUTION - KEEP CLEAN, DRY, AND FREE FROM OILS

(iv) In prominent place when filler box is open, preferably near liquid oxygen drain valve:

DO NOT OPEN DRAIN VALVE UNTIL DRAIN HOSE
AND DRAIN TANK ARE CONNECTED

(v) Other placards, such as one at the converter cautioning about the presence of liquid oxygen, may also be appropriate.

(7) Other installation criteria are given in Chapter 6, AC 43.13-2A, Acceptable Methods, Techniques, and Practices-Aircraft Alterations, dated June 9, 1977, and should be given full consideration.

(D) Precautions. The referenced SAE report contains precautions peculiar to a liquid oxygen installation, and this material should be reviewed. It should also be emphasized that liquid oxygen equipment and the aircraft being serviced must be electrically grounded during servicing to prevent an accumulation of static electricity and discharge. The following considerations are included for special emphasis:

(1) System Cleanliness. The completed installation shall be free of oil, grease, fuels, water, dust, dirt, objectionable odors, or any other foreign matter, both internally and externally prior to introducing oxygen in the system.

(2) Closures. Lines which are required to be disconnected, due to the location of the converter within the rotorcraft during rotorcraft maintenance checks or overhaul, should be capped to prevent materials which are incompatible with oxygen from entering the system when the system integrity is broken. Caps which introduce moisture and tapes that leave adhesive deposits shall not be used for these purposes. All openings of lines and fittings shall be kept securely capped until closed within the installation.

(3) Degreasing. All components of the oxygen system should be procured for oxygen service use in an “oxygen clean” condition. Parts of the oxygen system, such as tubing, not specifically covered by cleaning procedures should be degreased using a vapor phase trichloroethane degreaser. Ultrasonics may be used in conjunction with vapor phase degreasing for the cleaning of components.

(4) Purging. The system should be purged with hot, dry 99.5 percent pure oxygen gas in accordance with the manufacturers recommendations after:

(i) Initial assembly of the oxygen system; and

(ii) After system closure whenever the oxygen system pressures have been depleted to zero, or the system has been left open to atmospheric conditions for a period of time or is opened for repairs.

(5) Maintenance and Replacement. All parts of the oxygen system should be installed to permit ready removal and replacement without the use of special tools. All tubing connections and fittings should be readily accessible for leak testing with a leak test compound formulated for leak testing oxygen systems and for tightening of fittings without removal of surrounding parts.

(ii) Gaseous Oxygen.

(A) General. This guidance is intended to supplement the existing guidance in AC 43.13-2A, Chapter 6. If there are any differences within the two AC’s, this guidance should prevail since it pertains specifically to Part 27 requirements.

(B) System Components.

(1) High Pressure Cylinders. Many installations utilize hospital type cylinders rather than aviation type cylinders. A concern with the hospital type cylinders is the yoke and the hard plastic washer that is commonly used with these cylinders. It is very difficult to properly attach these yokes since the rotorcraft provides a high vibration environment and no positive lock is provided. Leaks are a continuous problem with this configuration. Yokes are available for these bottles that provide for a positive lock. Improved washers that provide for a good elastometric seal and include a metal ring to limit crushing the washer are also available. If the hospital type bottles are to be used, only the modified yokes and improved seals should be considered for future

installations. The preferred cylinder is the aviation type cylinder with the integral shut-off valve and regulator. All cylinders should be DOT approved.

(2) Lines.

(i) General. Any lines that pass through potential fire zones should be stainless steel.

(ii) High Pressure. Use of high pressure lines may be necessitated by the use of a pressure regulator that is remote from the cylinder. The intent is to locate the regulator as close as physically possible to the cylinder, and to minimize the use of fittings. Lines of 6-inch lengths are encouraged with 18-inch lengths being the maximum in unusual circumstances. Lines made of stainless steel are recommended.

(iii) Low Pressure. Although lines may only be subjected to low pressures, if they are located behind upholstery or for any reason are not 100 percent visible during normal operation, they should be solid metal lines or high pressure flexible lines such as Aeroquip 300 series hose or Stratoflex 124 or 170 series hose assemblies. The so called “green lines” should only be used in locations that are 100 percent visible during normal operation. This would restrict their use to the run between the mask and the bulkhead disconnect in the aircraft cabin. Synthetic lines such as plastic, nylon, or rubber cannot be recommended for applications that will be exposed to continuous pressure (i.e., as opposed to pressurized when needed). These materials can cold flow.

(3) Fittings.

(i) High Pressure. Intercylinder connections are made with regular flared or flareless tube fittings with stainless steel. Usually fittings are of the same material as the lines. Mild steel or aluminum alloy fittings with stainless steel lines are discouraged. Titanium fittings should never be used because of a possible chemical reaction and resulting fire. An example of a series of fittings that has been accepted is the “SS” series Swagelok tube fittings (flareless).

(ii) Low Pressure. Fittings for metallic low pressure lines are flared or flareless, similar to high pressure lines. Line assemblies should be terminated with “B” nuts in a similar manner to a manufactured terminating connection. Universal adapters (AN 807) or friction nipples used in conjunction with hose clamps are not accepted for use in pressurized oxygen systems.

(4) Shut-off Valve. Each system should contain a shutoff valve that is located as close as practical to the high pressure cylinder(s), and it should be assessable to a flightcrew member. High pressure cylinders should use slow opening/closing system shut-off valves. Where the regulator is part of the cylinder, and low pressure oxygen is controlled, the emphasis on slow acting valves is not as significant, and use of a flow fuse may be possible. Use of a flow fuse must be

supported by a system fault analysis and testing to show maximum flow will not result in nuisance trips, and reliable trips will be provided for malfunction conditions resulting in excess flow.

(5) Regulators. The regulator should be mounted as close as possible to the cylinders (reference b(9)(ii)(B)(2)(i)). If nonaviation qualified regulators are to be considered, their service history should be reviewed and careful consideration should be given to the manufacturer's environmental qualification. Radio Technical Commission for Aeronautics Document D0-160 is a recognized and accepted standard for environmental considerations. As a minimum, consideration should be given to operation during altitude, temperature, and vibration extremes.

(6) Placards. Appropriate, durable placards should be provided with the installed system. Emphasis should be placed on any precautions that are appropriate during filling of the system and so forth.

(7) Filler Connections. When a filler connection is provided, it is recommended it be located outside the fuselage skin or isolated in a manner that would prevent leaking oxygen from entering the rotorcraft. Careful evaluation should also be made of any nearby sources of fuel, oil, or hydraulic fluid under normal or malfunction conditions. Each filler connection should be placarded. In addition, any valve (on aircraft or ground servicing equipment) associated with high pressure should be slow acting.

(C) "Provisions Only" Considerations. In some instances systems are approved that only include provisions for a supply system consisting of the high pressure cylinders, regulators, and their associated lines and fittings. In these instances, a placard should be provided that refers to a supply system that is considered satisfactory for the remainder of the installation. Other supply system configurations may very well be acceptable; however, they should be evaluated by the ACO that evaluated the original installation. An example of an acceptable placard for this situation is:

> Oxygen Supply System must be in accordance with the requirements given in STC SH _________. Deviations to the configuration specified must be evaluated and approved by the Manager (include reference to the appropriate FAA ACO).

(11) Medical Communication Equipment. This equipment is provided to allow for communication between the rotorcraft and ground medical personnel. It includes voice communication and may also include telemetry equipment for the transmission of graphic data. It should be demonstrated that this equipment functions, and the range at which this determination was made should be recorded in the project file. The functional demonstration should include a 360° turn (clockwise and counterclockwise) to assure no significant sections of signal blanking exists. The remainder of the emphasis on this equipment should be to assure that operation of this equipment does not

interfere with normal operation of any avionic systems whose installation is required for safe operation of the rotorcraft.

(12) Cabin Lighting. EMS interiors normally include higher intensity cabin lighting than other interiors. This lighting capability should be carefully evaluated to ensure it does not interfere with operation of the rotorcraft. In some installations a special curtain is required to separate the cockpit from any interference by the lighting. The FAA/AUTHORITY project file should include a short discussion of how this evaluation was conducted. See paragraph b(6) for other curtain considerations.

(13) Other EMS Equipment. These items of equipment that are installed for the EMS mission are considered to be optional equipment and should be operated to assure they function properly. This evaluation would normally be done by someone that is knowledgeable about the particular type of equipment since correct operation of the equipment is essential to a valid determination that the required rotorcraft systems are not being interfered with. This includes all removable pieces of medical equipment that are used for patient care. The primary purpose of the evaluation of this equipment is to emphasize the possibility of any adverse interference between operation of the EMS equipment and the systems whose installation is required for safe operation of the aircraft, the adequacy of the installation provisions, and assurance that failure modes will not result in a hazardous condition for the rotorcraft.

(14) Miscellaneous. The following areas are not peculiar to EMS installations; however, their significance is enhanced by the complexity of an EMS installation.

(i) Compatibility. Many EMS installations are a collection of several STC's and may also include some "FAA/AUTHORITY field approvals." For this situation it should be shown that the overall installation provides for safe operation of the aircraft. Operation of a search light, if included, should be emphasized since this system can be difficult to keep out of the cockpit.

(ii) Electrical Load Analysis. An electrical load analysis should be conducted, and additional guidance is available in paragraph AC 27 MG 1. If the analysis indicates the generator(s) can be overloaded, appropriate measures should be taken to account for the problem. In some instances a placard that specifies certain operating limitations may be satisfactory while in other instances an electrical interlock may be in order. In general, if the amount of overload is relatively small, the placard solution will probably be satisfactory; whereas, if the amount of possible overload is significant, it is more likely that an interlock scheme will be necessary.

(iii) Aircraft Grounding. It should be emphasized in an appropriate place in the STC data (RFM, maintenance information, etc.) that any time the EMS systems are being operated or serviced (oxygen for example) on the ground, the rotorcraft itself must be grounded.

(iv) Electrical Outlets. All electrical outlets provided in the cabin should be the three-prong grounded type. When not in use, these outlets should be suitably protected against the entry of fluids.

(v) Placards. All medical outlets should be placarded (air, oxygen, vacuum, etc.). Electrical power outlets should be placarded for type of voltage and amperage capacity. A placard stating no smoking when oxygen is in use should be included. Other placards would include information appropriate to the oxygen system, operation of special controls, and so forth.

(vi) Equipment in Cargo and Baggage Compartments. When components are added to the baggage compartments, provisions should be made to protect the system components due to shifting cargo. In addition, when oxygen components are installed, the compartment should be placarded against the storage of oil or hydrocarbons. A smoke detector is recommended for a compartment if oxygen cylinders are installed in a closed, nonaccessible compartment. Also, the cargo weight limitations placard should be changed. Paragraph AC 27.787 pertains to cargo and baggage compartments.

(15) Equipment Substitution. The EMS modification that is presented for approval will contain specific items of equipment, and the approval will make reference to this equipment. If other equipment (new model, manufacturer, etc.) is to be substituted, then an evaluation should be made to assure the substitute equipment is also satisfactory. This evaluation would normally consist of comparing the attachment means, design features, failure modes, specifications, and operation of the two units. The purpose of the evaluation is to assure there are not differences that have an adverse effect on the airworthiness of the installation. Other differences would not be considered significant. Specific seats and litters are generally approved as a part of the EMS configuration. Substitution may be approved in accordance with the standards.

c. Related FAR Sections and References.

(1) FAR Sections. § 27.337, 27.471, 27.561, 27.773, 27.783, 27.785, 27.807, 27.831, 27.853, 27.1301, 27.1309, 27.1353, 27.1357, 27.1365, 27.1367, 27.1411, 27.1413, 27.1431, 27.1557(d), 27.1561, 27.1581(a)(2), 27.1583(d), 27.1585, and 27.1589.

(2) Other References.

(i) Helicopter Association International, Emergency Medical Services Recommended Guidelines, 1987, First Revision, 2 pages.

(ii) National Highway Traffic Safety Administration, Air Ambulance Guidelines, dated 1981.

(iii) FAR Part 91, General Operating and Flight Rules.

(iv) FAR Part 135, Air Taxi Operators and Commercial Operators.

(v) AC 67-1, Medical Information for Air Ambulance Operators, dated March 4, 1974.

(vi) AC 23-2, Flammability Tests, dated August 20, 1984.

(vii) Oxygen Equipment for Aircraft, Society of Automotive Engineers Aerospace Information Report No. 825B, Rev. 9/86.

(viii) Acceptable Methods, Techniques, and Practices--Aircraft Alterations, AC 43.13-2A, dated June 9, 1977.

(ix) Design and Installation of Liquid Oxygen Systems in Aircraft, General Specification for Military Specification MIL-D-19326G, dated October 1, 1985.

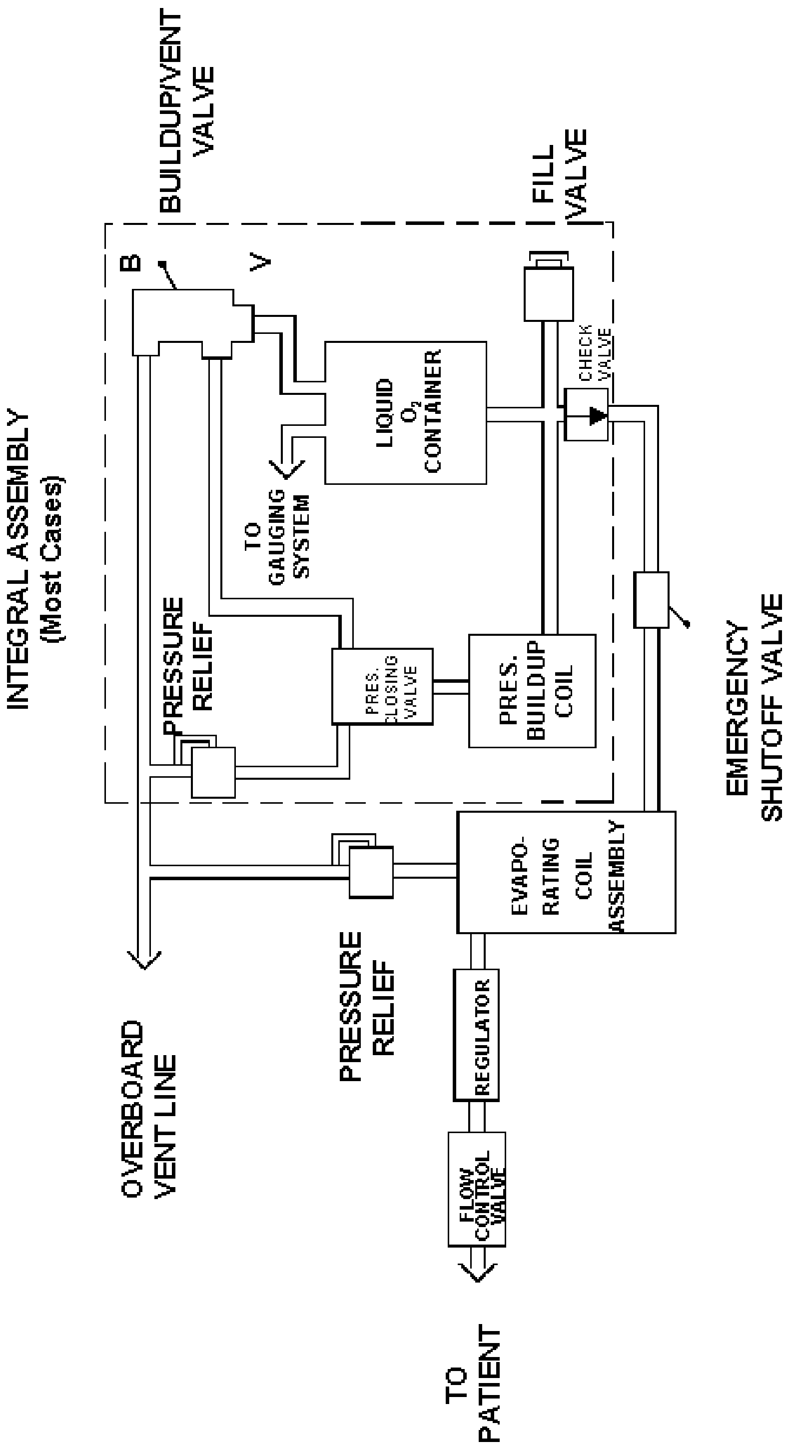

FIGURE AC 27.MG 6-1 TYPICAL LIQUID OXYGEN SYSTEM

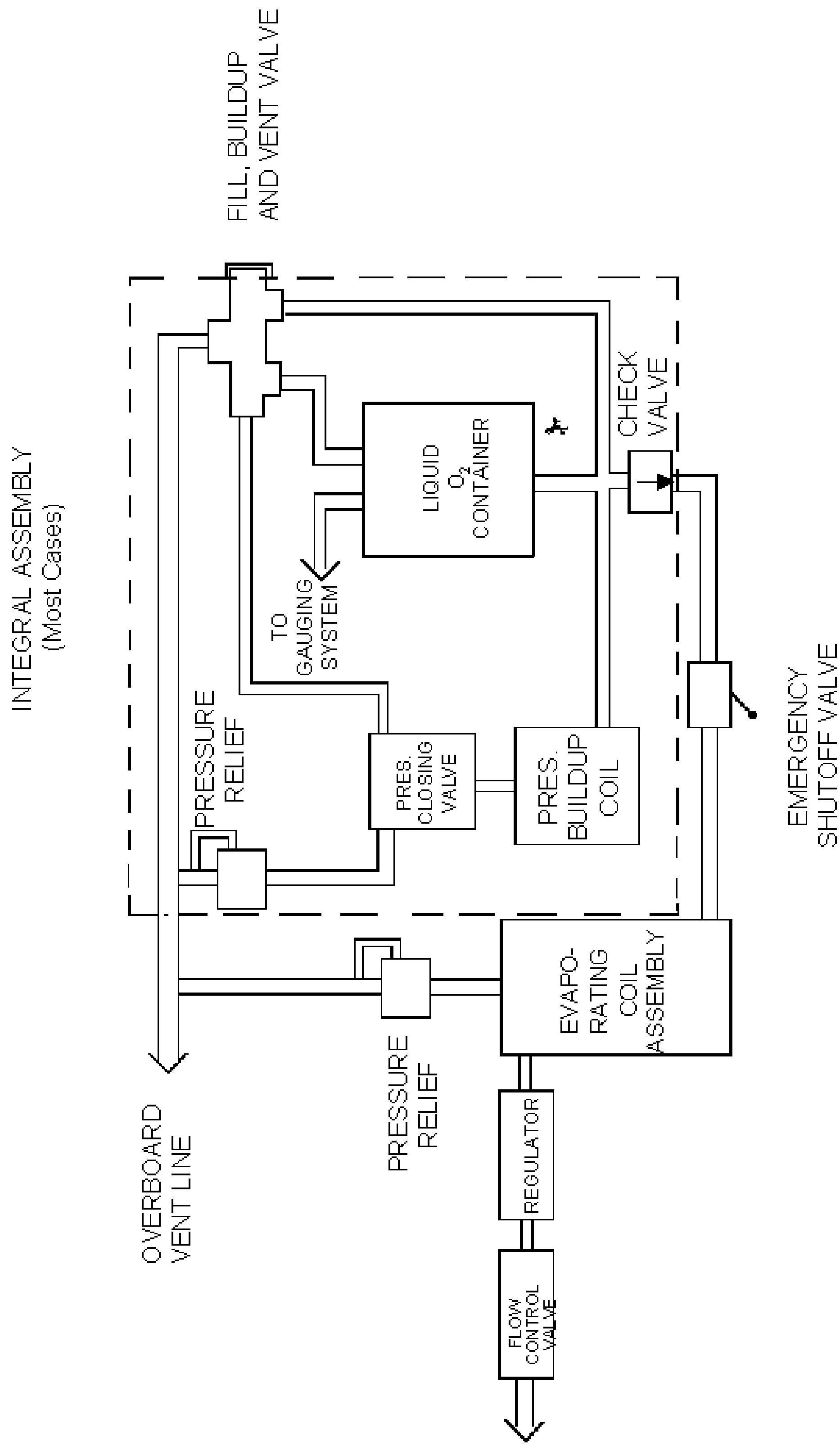

FIGURE AC 27 MG6-2 TYPICAL LIQUID OXYGEN SYSTEM - USING COMBINATION VALVE